A data receiver having means for minimizing interference and method used in such a receiver.

FIELD OF THE INVENTION.

The present invention relates to a data receiver having means for minimizing interference.

BACKGROUND OF THE INVENTION.

This kind of data receiver is used in mobile phones, which comply with the UMTS standard. For data transmission, this standard proposes to use spreading codes having orthogonality properties.

An important problem faced by such mobile phones is that the effect of propagation paths of the data is to be eliminated. A known solution for eliminating this interference is the use of the CPICH channel, which transmits 256 "1", transformed into "1+j" after modulation. So, at the receiver side in the mobile, the channel can be estimated in an easy way. The following references can be consulted as prior art considerations.

-3GPP TSG R1-00-1371

"CPICH interference cancellation as a means for increasing DL capacity"

-3GPP TSGR R4-01-0238

"CPICH interference cancellation as a mean for increasing DL capacity"

-3GPP TSGR R1-01-0030

"Further results on CPICH interference cancellation"

-3GPP TR 25.991 V2.0.0 (2001-03)

SUMMARY OF THE INVENTION.

The invention proposes to improve the cancelling of a certain amount of interference with respect of the prior art cited above. According to the invention, a data receiver is defined in the following way:

-A data receiver for receiving user data and reference data coming from a transmitter

via at least a channel, comprising means for unscrambling and means for despreading received data, means for analyzing the characteristic of the channel, means for evaluating the contribution of interference of data caused by the channel and a substracter means intended for cancelling the contribution of interference in the user data, said substracter means being placed before said unscrambling means.

These and other aspects of the invention are apparent from and will be elucidated, by way of non-limitative example, with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS.

The present invention will now be described in more detail, by way of example, with reference to the accompanying drawings, wherein:

-Fig.1 shows a system in which the invention is applied,

-Fig.2 shows a transmitter from which CPICH is transmitted,

-Fig.3 shows a data receiver according to the invention,

-Fig.4 shows a part of the receiver shown in Fig.3, and

-Fig.5 shows a second part of the receiver shown in Fig.3.

DETAILED DESCRIPTION OF THE INVENTION.

Fig.1 shows a system in which the invention is applied. The system is a CDMA system and concerns a cellular radio mobile system. Reference 1 shows a base station comprising a transmitter 2 having a high-frequency part 3 and the reference 5 a mobile station. The link from the base station to the mobile station or mobile is determined by a given scrambling code. The arrows P1, P2, P3.... indicate various paths, providing various delays $\tau 1$, $\tau 2$, $\tau 3$..., by which the waves are propagated from an antenna 6 connected to the output of the high-frequency part 3 to an antenna 8 that the mobile 5 comprises. The mobile station can be interfered by links that have a different scrambling code.

Fig.2 shows, the transmitter 2 in a schematic way. It comprises the high-frequency part 3 the output of which is connected to the antenna 6 and an input connected to a data multiplexer 12, via a transmitting filter 13. This multiplexer 12 receives, notably data from the user, which is indicated by a user box 15, and data

coming from the CPICH. The CPICH data are formed by a "1" sequence. Before transmission, theses data are scrambled by a scrambling sequence Scr thanks to a scrambling device 17; a spreading code Sp is also applied, as is known.

Fig.3 shows a mobile station 5 in a schematic way. As usual, it comprises a screen 25, a speaker 26, a microphone 27 and a keyboard 28. A general electronic part 29 manages all the tasks not specially covered by the invention. This Fig. shows a receiver part 30 in more detail. This part 30 comprises a high-frequency head 31 from which data are provided, after a high-rate receiving filter 32 elaborated by an over-sampling device 34. The high-frequency head 31 also supplies data to a channel estimator 35 and to a delay estimator 38, which determines the delays $\tau 1$, $\tau 2$, $\tau 3$..., of the cited paths P1, P2, P3..... Scrambling codes are delivered by a scrambling code generator 39 and spreading codes by a spreading code generator 40. All the codes provided by the elements 35, 38 and 39 can be used by a Rake type receiver 42. The output of this receiver 42 is connected to the input of the electronic part 29. The receiver 42 comprises a plurality of fingers RF1,..RFj,..RFk,..and RFJ as is usual for this kind of receiver. A combining device 45 combines all the information coming from the fingers to provide symbols.

Fig.4 shows the structure of the Rake finger RFj cooperating with the other parts of the receiver. The finger RFj comprises a plurality of interference estimators allocated to each path respectively. IEP1Fj is the interference estimator of the path 1 on finger 1. IEPkFj is the interference estimator of the path k on finger j and so on. The outputs of these estimators are added together by the adding device 60. The estimations of the interference are substracted from the data signal provided by the head 31 thanks to a substracter 62. The data signal are delayed by the delay device 61 which delays the data by an amount which has a relation to the delay of the path concerned. After this operation, an unscrambling operation is performed by the multiplier 64, which provides data from the scrambling code coming from generator 39. As the data are in complex form, a conjugate device 66 evaluates the conjugate of the scrambling code. This scrambling code is the scrambling code assigned to the link. Finally the data are despread by the multiplier 68 taking into account the code provided by the generator 40.

In Fig.4 the interference estimator IEPkFj is shown in more detai~~l~~ed. It comprises a plurality of correlators COR1...CORJ-1 the number of which is dependent on the number of paths. The output signals of these correlators are added together by the adder 70 and from here sent to the adder 60.

Fig.5 shows the structure of the correlator CORj. This correlator receives the scrambling codes Scrj of the other links which contribute to the interferences to be cancelled. Note that there are J-1 such correlators for each finger, as it is possible to eliminate the interference of all j paths with j≠k, with k being the finger under consideration. For this purpose, the estimate $\hat{h}j$ of the link and the delay τj of the other paths are considered. All these parameters are not the parameters of the main link but those of the parasitic ones. A multiplier 80 performs an operation concerning $\hat{h}$ and the value of the CPICH i.e. "1+j" in complex form. 2 N multipliers M(-N) to M(+N) perform an operation with the scrambling code of the parasitic link delayed in accordance with the delay τj s of these links. The output signals of these multipliers are applied to the operators ρ(-N) to ρ(+N). N is taken into consideration in relation to the number of interference coefficients ρ, each coefficient being generated by the cross-correlation of the transmitting and the receiving filter, as in the formula below (where for example value N=8, but this may vary as a parameter). An adder 85 sums all the signals at the output of these multipliers before they are applied to the adder 70.

The working of the channel estimator is facilitated by the "1" sequence formed, coming from the CPICH and transformed into "1+j" considered in complex form. In this way, the coefficients $\hat{h}$ of the impulse response of the channel are defined in an easy way. From these received data, the delay $\tau 1$, $\tau 2$, $\tau 3$ provided by the various paths P1, P2, P3,... are also estimated in the delay estimator 38.

Finally, the interference estimator carries out the following formula:

$$r(n) = \sum_{k=\Delta_{j,i}-8}^{\Delta_{j,i}+8} \rho(k*Tc-(\tau_j-\tau_i))*\hat{h}_j*S_{c,n+k*Tc}*S_{p,n+k*tc}*(1+j)$$

In this formula:

ρ is the cross-correlation between the transmit and receive filter,

$\hat{h}_j$ is channel coefficients of the path j,

$S_{c,n}$ is the scrambling sequence,

$S_{p,n}$ is the spreading sequence of the pilot channel,

1+j is the CPICH symbol,

Tc is the duration of a chip (time slot obtained after scrambling),

$\tau_j - \tau_i$ is the delay between the path i and the path j,

with:

$$\tau_1 - \tau_0 = \Delta_{1,0}.T_c + \Omega_{1,0}.\frac{T_c}{OS} \qquad |\Omega_{1,0}| \langle OS$$

OS is an integer that represents an over-sampling factor. $\Delta_{1,0}$ is an integer which measures the delay in T_c unit and $\Omega_{1,0}$ the number of over-sampling periods.

It is to be understood that the invention covers the case for which the realization of all the embodiments disclosed is made by a processor and convenient software.